plant breeding studies on elephantgrass and has developed several accessions. However, Embrapa has not evaluated the nutritional quality of the various accessions of elephantgrass. The objective of this study was to determine nutritional quality of Embrapa's elephantgrass collection. Over a 3-yr period, CP, in vitro and in vivo digestibilities (DIG), lignin (L), cellulose (C), and silica (S) of leaf blade and of whole green chopped plants of 74 elephantgrass accessions were evaluated at three different cutting (harvesting) periods of 30, 60, and 90 d. Data were analyzed as a complete randomized block with in two replicates. The statistical model included forage type (leaf vs whole plant), accession, cutting day, all two-way interactions, and the three-way interaction. The greatest variability ($P < 0.02$) was found at 60 d among all accesses. Differences ($P < 0.05$) were found among accessions in nutritional quality except C, L, and S. Crude protein decreased sharply with age from 17 to 4% CP for 30 to 90 day old grasses. For in vitro DIG, largest variability was from 68 to 49% for 30 to 90 day old grasses ($P < 0.02$). Considering the sharp decrease in CP, elephantgrass should be grazed around 30 d and no more than 60 d. For green chopping, CP after 60 d is considered extremely low for rumen function. The differences among nutritional qualities in the elephantgrass accessions could be responsible for wide differences in growth and lactation performance of grazing ruminants. Further research by plant breeders is needed to improve Embrapa's elephantgrass accessions in CP, and in vitro DIG.

Key Words: Elephantgrass, Nutrition Quality, Accession

T206 Yield and growth of *Panicum maximum* Jacq under different fertilization levels with N and P in humid tropical forest conditions. A. Rodriguez-Petit* and J. Zambrano, *Universidad Nacional Experimental Sur del Lago*.

An experiment was carried out to evaluate the yield and growth of the guinea grass (*Panicum maximun* Jacq) under different levels of N and P. The soils was taxonomically classified as Inceptisols, with pH 5.6. Three levels of N (0, 100 and 200 kg/ha/year) and three of P (0, 50 and 100 kg/ha/year) were evaluated in a design of split-pot with factorial arrangement in the secondary plot and four replications. The variables were height (H), total yield (TY), leaf yield (LY), stem yield (SY) and dead material yield (DMY) and were measured every 7, 21 and 35 days in three 35 day cycles. The guinea grass showed significant differences ($P<0.01$) for H, the highest value (172.33 cm) was obtained with the interaction of 200 kg N/ha and 100 kg P/ha. The most highest values to TY, LY and SY were observed at the 35 day by the simple effect of 200 kg N/ha (3940.31, 2381.47 and 1403.18 kg/MS/ha, respectively). The DMY not show statistical differences by treatments effect. The best performance of the guinea grass under this trial conditions was obtained every 35 days with the application of 200 kg N/ha/year and 100 kg of P/ha/year.

Key Words: *Panicum maximum*, Fertilization, Yield

T207 Evaluation of energy efficiency and CO_2 emission from forage production systems. M Wachendorf*, M Kelm, and F Taube, *University of Kiel, Kiel, Germany*.

Fossil energy use in agriculture is an important indicator for both the use of limited fossil resources and the release of carbon dioxide (CO_2) and other combustion gases. Based on experimental data, gathered within an integrated project on nitrogen fluxes in intensive dairy farming, an analysis of fossil energy input and energy efficiency in forage production from permanent grassland and maize was conducted. The grassland experiment consisted of all combinations of five defoliation systems, i.e. cutting-only, rotational grazing, mixed systems with one or two silage cuts plus succeeding rotational grazing respectively, and simulated grazing, four mineral N application rates (0, 100, 200, and 300 kg N ha^{-1} yr^{-1}), and two slurry levels (0 and 20 m^3 slurry ha^{-1} yr^{-1}). Prior to the start of the experiment, white clover was established in all plots by oversowing. Silage maize was grown without and with undersown ryegrass and comprised different rates of mineral N (0, 50, 100, 150 kg N ha^{-1} yr^{-1}) and slurry application (0, 20, 40 m^3 ha^{-1} yr^{-1}). Energy efficiency consistently decreased with increasing rates of mineral N application both in permanent grassland and silage maize. Application of 20 m^3 slurry per hectare increased energy efficiency in grazed grassland and silage maize, but not in cut grassland. Net energy yields of all grassland defoliation systems were much lower compared to maize at the same level of energy input. Silage maize was thus much more energy-efficient due to high net energy yields at low to moderate levels of nitrogen and energy input. The figures for fossil energy input and CO_2 emissions showed an almost similar pattern since the CO_2 emission factors for N fertilizer and diesel fuel were in a similar range. A CO_2 mitigation of 300-500 kg CO_2 ha^{-1} seems to be possible in forage production without a significant reduction in productivity. It is proposed that the environmental performance of dairy farming systems can be improved substantially by a change from N-fertilized grass-only swards towards unfertilized clover/grass swards and silage maize.

Key Words: Forage production, CO_2 emission, Energy efficiency

T208 Impact of maturation on cell wall degradability in corn stem internodes. H. G. Jung*, *USDA-ARS, St. Paul, MN*.

Degradability of forage cell wall (CW) material declines with maturity; however, the causes for this decline have not been adequately described. Stem CW development and degradability were observed in three nonrelated corn hybrids. The fourth above-ground stem internode was collected in 1998 and 1999 from a randomized complete block design field trial with two replications. Sampling began when the internode was 1-cm long (late June) and subsequent samples were collected 2, 4, 8, 12, 19, 26, 40, 68, and 96 d later. Internodes were analyzed for CW concentration and composition, and 24- and 96-h in vitro rumen degradability. While small significant differences were observed in CW development and degradability of the three corn hybrids, impact of maturity was much greater and all hybrids responded similarly to maturation. Stem internodes increased in length and diameter until 12 d after sampling began. CW concentration was 31% of internode OM in the first samples and did not change during the next 8 d of development. Subsequently, CW concentration increased at each sampling until a maximum (73%) was reached 26 d after sampling began, later CW concentration declined (minimum of 55%) because of sucrose accumulation in the stem. CW glucose and xylose concentrations increased from 35 and 18% of CW, respectively, in the first sample to 52 and 24% of CW 12 d later. In contrast, Klason lignin concentration declined from 11% of CW to 6% by 8 d after sampling had begun and then increased to 20% of CW by d 40. Degradability of internode CW polysaccharides was high and unchanged through d 4 (88 and 93% after 24 and 96 h, respectively), but then declined steeply to 26 and 39% (24 and 96 h, respectively) by d 68. Lignin/polysaccharide cross-linking by ferulates matched the beginning of the decline in CW degradability better than lignin concentration because these ferulates began to increase in concentration at the same time as the decline in degradability started whereas lignin concentration was still decreasing. These data indicate that the decline in CW degradability associated with maturation of grasses is a function of both lignin and ferulate cross-linking.

Key Words: Corn Stem, Cell Wall, Degradability

Dairy Foods: Cultured dairy products and dairy proteins

T209 Dissociation of casein supramolecules. B. S. Oommen* and D. J. McMahon, *Department of Nutrition and Food Sciences, Utah State University*.

Microstructure of dissociated caseins in bovine milk was studied using transmission electron microscopy. Cold and warm milk was treated with excess EDTA and glucono-δ-lactone to dissociate the colloidal casein aggregate. This was diluted 100 times, and caseins were adsorbed on to parlodion coated copper grids. Parlodion coated copper grids were coated with poly-L-lysine to improve the adsorption of protein on to the film. These grids were stained using uranyl acetate and oxalic acid, flash frozen in liquid nitrogen-cooled Freon 22, and freeze dried so that the native casein structure could be preserved. Grids were viewed using a transmission electron microscope and images were photographed at various magnifications ranging from 7,000x, to 250,000x at 80 kV. Cold milk EDTA-treatment resulted in linear and spherical aggregates of proteins. Warm milk EDTA- treatment resulted in filigreed ring-like protein aggregates. Fixing of the colloidal casein particles using gluteraldehyde before EDTA-treatment preserved the supramolecular structure of ca-

sein. Reduction of pH first resulted in small protein aggregates which further dissociated out of the supramolecule. This study reveals the various types of aggregation behavior of caseins when calcium is removed from the colloidal casein structure.

Key Words: Casein micelle, Acid, Calcium

T210 Antimicrobial activity of bovine milkfat globule membranes: A cautionary tale. D. A. Clare*, T. R. Klaenhammer, H. M. Hassan, G. L. Catignani, and H. E. Swaisgood, *North Carolina State University, Raleigh, N.C. / USA*.

Milkfat globule membranes (MFGMs) were prepared from bovine milk according to standard procedures. MFGMs and peptide hydrolysates, generated by incubation with immobilized trypsin, were screened for antimicrobial activity using three foodborne pathogens: *Escherichia coli* 0157:H7, *Listeria monocytogenes*, and *Salmonella typhimurium*. Two probiotic microorganisms, *Lactobacillus acidophilus* and *Lactobacillus gasseri*, were also included for evaluation purposes. Assays were performed on beef heart infusion (BHI) plates seeded with lawns of indicator cells, and protein/peptide fractions were spotted to monitor the zone of inhibition (ZOI). Initial results showed that these samples were active against *S. typhimurium* and *E. coli* 0157:H7. During the course of our studies, we have determined that bacteriostatic/bactericidal effects were most likely due to the generation of hydrogen peroxide (H_2O_2) by xanthine oxidase (XOX), a major protein constituent of the MFGMs. Similarly, purified XOX, evaluated under identical experimental conditions, showed analogous data trends including inhibitory effects with respect to *L. monocytogenes*. Probiotic *Lactobacillus* strains were only marginally affected. Microbial growth patterns were not influenced, however, when MFGMs, trypsin-generated MFGM hydrolysates, and XOX were evaluated for activity using Luria-Bertani (LB) test plates. Thus, the mechanism of this action was attributed to catalysis of purine substrates present in BHI but lacking in LB media. Furthermore, addition of catalase to XOX samples totally abolished the antibacterial effects, and microbial growth was not impaired when ZOI assays were performed using BHI plates under anaerobic conditions. Apparently, proteolysis of MFGMs using immobilized trypsin did not completely eliminate the catalytic (antimicrobial) capacity of XOX; whereas, sequential treatment with pepsin at pH 3.5 followed by digestion with trypsin at pH 8.1 resulted in complete inactivation of both enzymatic and bactericidal functions. Ultimately, antimicrobial properties of XOX were entirely associated with the oxidase form of the enzyme resulting in the production of H_2O_2 as the active inhibitory component.

Key Words: Milk enzymes, Antimicrobial proteins, Bactericidal reagents

T211 *In Vitro* stability of β-galactosidase microcapsules. H. S. Kwak, J. B. Lee, B. J. Jeon, and J. Ahn, *Sejong University, Seoul, Korea*.

The present study was carried out to examine the efficiency of microcapsules and a stability of lactase in vitro in the simulated gastric and intestinal conditions. As a coating materials, medium-chain triacylglycerol (MCT) and polyglycerol monostearate (PGMS) were used. The highest efficiency of microencapsulation was found in the ratio of 15:1 as coating to core material with both MCT (91.5%) and PGMS (75.4%). In a subsequent experiment, lactose content was measured to study a microcapsule stability. Lysis of microcapsules made by MCT in simulated gastric fluid was proportionally increased such as 3% in pH 5 and 11% in pH 2 for 20 min incubation. In the case of PGMS microcapsulation, 11-13% of lactose was hydrolyzed at 20 min in all pHs and also very little amount (less than 3%) of lactose was hydrolyzed after 20 min in all pHs. The highest percentages of lactose hydrolysis in MCT and PGMS microcapsules were 68.8 and 60.8% in pH 7 and 8 during 60 min, respectively. Based on out data, the lactase microcapsules seemed to be stable when they stay in the stomach, and hydrolyzed rapidly in small intestine where the bile acid was excreted.

Key Words: β-galactosidase, Stability of microcapsule, Lactose

T212 Microencapslation of water-soluble isoflavone and physico-chemical property in milk . J. S. Seok, I. H. Ko, and H. S. Kwak, *Sejong University, Seoul, Korea*.

This study was carried out to investigate the addition of water-soluble isoflavone into milk by means of microencapsulation technique. The yield of Microencapsulation, sensory attributes, and capsule stability of water-soluble isoflavone microcapsules in milk were measured during 12 days. Coating materials used were polyglycerol monostearate (PGMS) and medium-chain triacylglycerol (MCT), and core material was water-soluble isoflavone. The encapsulation yield of water-soluble isoflavone with MCT was 74.5 % and was 67.2 % with PGMS when the ratio of coating material to core material was 15 : 1. The rates of water-soluble isoflavone release were 15, 20, and 25% when stored at 4, 20, and 30 for 12 days in milk, respectively. In sensory evaluation, beany flavor and color of microcapsuled water-soluble isoflavone added milk were significantly different from control and uncapsuled water-soluble isoflavone added milk, however, bitterness was not significantly different. In vitro study, microcapsules of water-soluble isoflavone in simulated gastric fluid with the range of 3 to 6 pHs were released 3.0 to 15.0%, however, the capsules in simulated intestinal fluid with pH 7 were released 95.7% for 40 min incubation time. In conclusion, this study provided that MCT and PGMS as coating materials were suitable for the microencapsulation of water-soluble isoflavone, and the capsule containing milk did not affect to sensory attribute.

Key Words: Isoflavone, Microencapsulation, Milk

T213 FAT free sugar free plain set yogurt fortified with folic acid. C. A. Boeneke* and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge, LA*.

Folic acid fortification is used in the prevention of neural tube defects such as spina bifida and ancencephaly, heart defects, facial clefts, urinary tract abnormalities, and limb deficiencies. Although yogurt is not a good source of folic acid, fortification could aid in prevention of above mentioned defects. Fortification of yogurt with folic acid may or may not change its physico-chemical characteristics. Fat free sugar free yogurt was manufactured using 0, 25%, 50%, 75% and 100% of the recommended daily allowance of 400 micrograms of folic acid. Treatments included addition of folic acid at these levels before and after pasteurization. The objective was to examine the effects of folic acid on viscosity, pH, TA, syneresis, color, composition, and folic acid concentration in the product at one, three, and five week intervals. Data were analyzed using the General Linear Model procedure with a completely randomized block design by the Statistical Analysis System. Significant differences were determined at $P<0.05$ using Duncan's Multiple Range Difference Test. There were no significant differences in viscosity over the five week period. No significant differences were found in pH or syneresis of samples. Folic acid fortified yogurts showed significantly higher($P<0.05$) b* values than control indicating they were more yellow in color. There were no differences in the electrophoretic mobilities of the protein/peptides in the samples. Control yogurt had significantly higher($P<0.05$) mean flavor scores than yogurts with folic acid when tested by a trained sensory panel. Folic acid fortification of yogurt impacted some of its physico-chemical attributes.

Key Words: Fermented, Health, Sensory

T214 Microstructure of folic acid fortified fat free sugar free plain set yogurt. K. J. Aryana*, [1]*Louisiana State University Agricultural Center, Baton Rouge, LA*.

Folic acid is used in preventing birth defects of the spine and brain, hardening of arteries and colon cancer. Yogurt is not good source of folic acid. Earlier experiments on fortifying yogurt with folic acid revealed that at a high level of folic acid fortification, the yogurt has a powdery mouth-feel. This powdery mouth-feel may be due to localized protein aggregations. The objective was to study the microstructure of folic acid fortified yogurt. Folic acid was added before and after pasteurization viz. during mix preparation and after culture addition. Folic acid was added at one quarter and one half the recommended daily allowance. The microstructure was studied using scanning electron microscopy and transmission electron microscopy. Control yogurt and folic acid fortified yogurts showed the network of casein micelles in chains and clusters. Clusters in the folic acid fortified yogurts were larger ($P<0.05$) compared to the control. Also the folic acid fortified yogurts had significantly ($P<0.05$) more clusters of casein micelles per unit area compared to the control. These increased localized casein micelle aggregations were a factor contributing to the powdery mouth-feel of folic acid fortified yogurts.

Key Words: Structure, Fermented, Network

T215 Development of cholesterol-removed compound whipping cream by β-cyclodextrin. S. Y. Shim, H. J. Choi, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was carried out to investigate the development of cholesterol-removed whipping cream. Cream with 36% milk fat was treated for cholesterol removal with 10% β-cyclodextrin, 40°C stirring temperature, 400, 800 and 1,200 rpm stirring speeds, and 10, 20 and 30 mins stirring time. The group of emulsifier and stabilizer was selected 0.3% β-cellulose, 0.3% sugar ester, 0.2% avicell, 0.3% sodium alginate, and 0.3% sucrose for making the cholesterol-removed compound whipping cream. The overrun percentage was the highest with 150%, and the foam stability was the most stable with 1.0ml defoamed cream when the ratio of cholesterol-removed whipping cream and palm oil whipping cream was 8 : 2. TBA values of the cholesterol-removed compound whipping cream were initially 0.08 and 0.15 after 4 week storage at 4° for sample. This result was not significantly different from cholesterol-removed whipping cream. In sensory evaluation, the scores of texture, cream flavor, color and overall acceptability in samples were not significantly different from cholesterol-removed whipping cream. In conclusion, cholesterol- removed compound whipping cream appeared to be stable under various experimental optimum conditions. Therefore, this study suggested the possibility of cholesterol-removed whipping cream in industry.

Key Words: Cholesterol removal, β-cyclodextrin, Compound whipping cream

T216 Development of cholesterol-removed compound whipping cream by β-cyclodextrin. S. Y Shim, H. J. Choi, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was carried out to investigate the development of cholesterol-removed compound whipping cream. Cream with 36% milk fat was treated for cholesterol removal with 10% -cyclodextrin, 40 stirring temperature, 400, 800 and 1,200 rpm stirring speeds, and 10, 20 and 30 mins stirring time. The group of emulsifier and stabilizer was selected 0.3% -cellulose, 0.3% sugar ester, 0.2% avicell, 0.3% sodium alginate, and 0.3% sucrose for making the cholesterol-removed compound whipping cream. The overrun percentage was the highest with 150%, and the foam stability was the most stable with 1.0ml defoamed cream when the ratio of cholesterol-removed whipping cream and palm oil whipping cream was 8 : 2. TBA values of the cholesterol-removed compound whipping cream were initially 0.08 and 0.15 after 4 week storage at 4 for sample. This result was not significantly different from cholesterol-removed whipping cream. In sensory evaluation, the scores of texture, cream flavor, color and overall acceptability in samples were not significantly different from cholesterol-removed whipping cream. In conclusion, cholesterol- removed compound whipping cream appeared to be stable under various experimental optimum conditions. Therefore, this study suggested the possibility of cholesterol-removed compound whipping cream in industry.

Key Words: Cholesterol removal, β-cyclodextrin, Compound whipping cream

T217 Aerobic endospore distribution in a process to produce high phospholipid ingredients from commercial reconstituted buttermilk. L. Lassonde* and R. Jimenez-Flores, *Cal Poly DPTC.*

Bacterial endospores survive standard industrial processes to become food spoilage organisms when later reconstituted with water and exposed to appropriate environments to induce germination and growth. The objective of the study was to 1) Isolate and characterize a library of wild-type *Bacillus spp.* from a variety of commercial buttermilk powder (BMP) including endospore counts, metabolic activity and germination rates; 2) Characterize rejection of endospores in a pilot scale cold microfiltration process on reconstituted BMP; and 3) Characterize the survivability of endospores when exposed to super critical CO_2. The library of endospores isolated from commercial reconstituted BMP consists of 80 well- characterized strains of bacilli. Biological comparisons are possible at DPTC with bacilli from different dairy products. The process used reconstituted BMP (20 L per batch and 10% TS) and subjected to a micro- filtration process using a 0.8μm ceramic porous filtering system at 4°C, to enrich phospho-lipids into the retentate. Diafiltration with distilled water was added through the system three times the original volume of the reconstituted buttermilk (60 L). Both retentate and permeate were analyzed for TPCs, mesophilic and thermophilic endospore counts to determine endospore counts in the retentate. Mesophilic-spore counts in retentate and permeate were consistently $>10_2$ cfu/ml and <25 cfu/ml respectively. Retentate and permeate thermophilic spore counts were 10_3cfu/ml and <5cfu/ml respectively. The original BMP had meso- and thermophilic counts of 10_2 and 10_3 cfu/ml. The total balance of spores in the system resulted in a retention of between 75 to 98% of the total spores, and no significant difference between mesophilic and thermophilic counts. Supercritical inactivation of spores show a complex, thermal/supercritical lethal curve. It is apparent that the overall composition of the BMP interferes with the spores exposed to the treatment. Destruction rates were measured between 90 to 99.9% of the original spores in the retentate.

Key Words: Buttermilk powder, Micro-filtration, Bacillus

T218 Time-intensity measurement of "creaminess" in dairy mixes. T. M. Kruel*[1], K Adhikari[1], H Heymann[2], and I. U. Gruen[1], [1] *University of Missouri-Columbia,* [2] *University of California-Davis.*

Time-intensity (T-I) analysis is a descriptive analysis where a single attribute is tracked as it changes over a period of time. Temporal measurements have mainly been done on flavor release attributes of foods during eating. Texture attributes have mostly been evaluated using unipoint measurements. Therefore, the objective of the present study was to determine if the attributes that constitute creaminess could be evaluated by T-I analysis. Five combinations of dairy mixes with varying fat content were chosen for evaluation. The intensities of "fattiness", "smoothness", and "thickness" were measured individually for each dairy mix by a panel of 5 trained judges. All the samples were randomized, served in 50-ml deli cups and coded with 3-digit random numbers for taste evaluations. Two replications were carried out and the data was collected on Compusense® 5. Attribute intensity was measured every 0.1 second for a total of 20 seconds. Data analysis (Unscrambler® 7.8) included Non-centered Principal Component Analysis (PCA) to extract Non-centered Principal Time-Intensity Curves (NPTIC) by using the panelists' responses. Product differences were further analyzed by using Partial Least Square Regression (PLSR). The variance explained by the 1st two principal components for "smoothness", "fattiness" and "thickness" were 69 and 17%, 84 and 9%, and 93 and 3%, respectively. Results from "smoothness" showed no pattern depending on the fat content. Probably the absence of any perceptible particles in the mixes governed the randomness of the results. On the other hand, both "fattiness" and "thickness" were perceived by the judges to be part of creaminess and the results showed distinct differences between low fat and high fat dairy mixes. It might be concluded that temporal measurements of "fattiness" and "thickness" could be used to determine creaminess of liquid dairy products. The "smoothness" of the products might not contribute much towards the perception of creaminess.

Key Words: Dairy mixes, T-I analysis, PLSR

T219 Identification of aroma compounds in whey powder. S. Mahajan, M. Qian*, and L. Goddik, *Oregon State University.*

Volatile compounds from whey powder were extracted with pentane-diethyl ether and followed by solvent assisted flavor extraction. The aroma concentrates were analyzed by gas chromatography/olfactometry technique and mass spectroscopy. Acetic, benzoic, butanoic, hexanoic, octanoic were the major acidic compounds identified in the whey. Other acidic compounds identified were formic, propanoic, 2-methylpropanoic and 3-methylbutanoic acids. Major neutral compounds identified were dimethylsulfone, maltol, 2-furanmethanol, dihydro-3-hydroxy-2(3H)-furanone, hydroxydimethylfuranone and ethyl acetate. The odor-active compounds were studied using an Osme technique.

T220 Ingredient interactions with derivatized whey protein powders. J. D Firebaugh* and C. R. Daubert, *North Carolina State University, Raleigh, NC.*

Justification: Whey protein was modified to produce powders capable of thickening similar to pregelatinized starches. A basic understanding of ingredient interactions with the new whey ingredient will encourage optimal incorporation into dairy foods.

Objective: To investigate pH and salt interactions with a derivatized whey protein powder.
Methods: Whey protein isolate (WPI) solutions were modified through acid and thermal treatments, then spray dried into powders. Samples were prepared by hydrating the derivatized powders in deionized water and adjusting the sample pH from 3.35 to 4.0, 4.5, and 5.0 with 6M HCl. Salt studies were prepared by hydrating the derivatized ingredient in 0.05M, 0.10M, and 0.15M NaCl solutions and adjusting to pH 4.0 with 6M HCl. Physical properties were determined for each solution. Specifically, rheological properties of solutions were obtained using a controlled-stress rheometer with concentric cylinder geometry at 25°C. Also, a water absorption index was evaluated and calculated as the weight of gel obtained from 1g of dry sample post hydration.
Results: Water absorption and viscosity were affected by pH. The derivatized ingredient was calculated to have a water absorption index of 7.5 at native pH (3.35). As pH was raised to the isoelectric point, the absorption index decreased significantly. For viscosity assessment, a 50 1/s shear rate was selected for all comparisons. As the pH was elevated to 5.0 an 8% protein solution displayed a decreasing viscosity, ranging from 1000 mPa s to <100 mPa s (pH 5.0). As the ionic strength of the solutions was decreased at a constant pH of 4.0, the viscosity increased from 1.5 mPa s (0.15M NaCl) to 3.5 mPa s (0.05M NaCl).
Significance: Information on derivatized protein interactions with other ingredients common to dairy foods will expedite the development of applications with the novel dairy ingredient, particularly in those foods desiring an all-natural, or all dairy, food label.

Key Words: Whey, Rheology, Stabilizer

T221 Effect of drying methods on the physical and chemical properties of whole milk powder. L. F. Osorio*[1], J. U. McGregor[2], J. S. Godber[3], and N. Y. Farkye[4], [1]*Escuela Agrcola Panamericana, Zamorano, Tegucigalpa, Honduras,* [2]*Food Science and Human Nutrition Dept., Clemson University, Clemson, SC,* [3]*Food Science Dept., LSU Ag Center, Baton Rouge,* [4]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*

The composition and properties of the milk, manufacturing procedures, thermal processing during manufacture, and drying technique are important variables that affect the quality of milk powders. Milk powders are widely used as food ingredients because they provide many functional properties. The objectives of this study were to evaluate the effect of various drying technologies on the physical-chemical stability of whole milk powder (WMP). WMP was manufactured by three different drying technologies: commercial spray; pilot spray and pilot pulse. Samples were evaluated for their physical-chemical characteristics and oxidative stability. Samples were stored at 45°C for 50 days in an incubator to accelerate oxidation. Samples were tested every 10 days for oxidation progress. Commercial spray dried WMP produced significantly less free fat, which suggests more efficient drying in terms of forming complete powder granules. Physical and chemical differences existed when comparing commercial spray drying and pilot spray drying systems. More stable and continuous operating temperatures and air flow of commercial dryers resulted in powders with better color and solubility values. Commercially dried WMP was more stable to oxidation compared to pilot spray dried and pilot pulse dried WMP. The two pilot scale technologies produced close to four times more mg malonaldehyde/kg than commercial spray dried WMP. Our results call into question the practical value of conclusions obtained from WMP research based on the use of pilot scale driers.

Key Words: Whole milk powder, Functional properties, Drying technology

T222 Effect of drying technologies on the microstructure of whole milk powder. L. F. Osorio*[1], J. U. McGregor[2], J. S. Godber[3], and N. Y. Farkye[4], [1]*Escuela Agrcola Panamericana, Zamorano, Tegucigalpa, Honduras,* [2]*Food Science and Human Nutrition Dept., Clemson University, Clemson, SC,* [3]*Food Science Dept., LSU Ag Center, Baton Rouge,* [4]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*

The functional properties of dried milk products are related to the physical structures of the milk powder particles. These particle structures are influenced by the conditions of drying and by the various atomizing systems employed by the drying technologies. Scanning Electron Microscopy (SEM) is an appropriate technique to study the surface morphology as well as the internal structures of the milk powder particles and their relation to functional properties. The objectives of this study were to evaluate the effect of drying technologies on the microstructure of whole milk powder (WMP) manufactured using commercial spray, pilot spray and pilot pulse dryers. Powder samples produced using all three dryer technologies were evaluated using a Hitachi S-3500 N SEM. We were also able to observe hydrated samples of the powder by using variable pressure to simulate an environmental SEM. Pilot spray dried WMP had more broken granules than commercial dried WMP. The granule distribution was less uniform than commercial drying and small granules were entrapped in larger broken granules. Pilot dried powders had a higher free fat content that may have been related to a higher percentage of broken granule particles. Pilot pulse drying produced WMP granules with black indentions on the surface which could be burned crystallized lactose. Granule size varied greatly in the pilot spray dried powders. Pilot pulse dried WMP did not have as many broken granules as pilot spray dried WMP. Pilot pulse dried WMP was expected to have better solubility because of more wrinkled surfaces when compared to spray drying. Our insolubility test did not support this physical characteristic. Spray drying produced large central air vacuoles where as pilot pulse drying produced numerous air vacuoles inside the granule. This may lead to an increase in particle density since less air is present inside the granules. This observation is a potentially important discovery because an increase in the number of oxygen containing vacuoles may cause an increase in the oxygen surface contact area, promoting and accelerating oxidation in pilot pulse dried WMP.

Key Words: Whole milk powder, Microstructure, Drying technologies

T223 Effect of glycomacropeptide and homogenization pressure on particle size and torsional fracture of heat induced whey protein emulsion gels. . R. Suhareli, G. Perez-Hernandez*, and R. L. Richter, *Texas A&M University.*

A mixture for emulsions with 10% protein and 20% butter oil were prepared by dispersing sweet whey protein concentrate (SWPC), acid whey protein concentrate (AWPC), or AWPC + glycomacropeptide (GMP) in distilled water. The mixture was heated to 65°C and homogenized at 20 and 90 MPa. Whey protein emulsions were heated to 90°C for 30 min in a closed water bath to form gels. The addition of GMP to the AWPC emulsion did not cause a reduction ($p>0.05$) in the diameter of the fat globules after homogenization at 20 and 90 MPa. The mean particle size (d_{vs}) in the emulsion made from SWPC homogenized at 90 MPa was lower ($p<0.05$) than the d_{vs} of particles in the emulsion made from AWPC + GMP that was homogenized at 90 MPa. However, the d_{vs} in the emulsion made using SWPC was not different ($p>0.05$) from d_{vs} in the emulsion prepared from AWPC after homogenization at 90 MPa. The differences in particle size attributed to homogenization pressure were not different. Gels made using AWPC and AWPC + GMP had a higher shear stress at fracture (hardness) than gels made using SWPC. The shear stress at fracture of gels made using AWPC and homogenized at 20 MPa was 13.48 kPa and increased to 23.81 kPa when the emulsions were homogenized at 90 MPa. The shear stress at fracture of gels made using the AWPC + GMP emulsion homogenized at 20 MPa was 15.06 kPa and increased to 22.07 kPa when emulsion was homogenized at 90 MPa. The shear stress at fracture for gels containing AWPC + GMP was similar to the shear stress value at fracture for gels made from AWPC. Gels made using SWPC emulsions exhibited a higher shear strain ($p<0.05$)at fracture and had a more rubbery texture than gels made from AWPC and AWPC + GMP which had a lower shear strain at fracture value and a brittle texture.

Key Words: Glycomacropeptide, Whey protein gels, Homogenization pressure

T224 Rheological properties at fracture of thermally induced whey protein with lecithin emulsion gels. . G. Perez-Hernandez*, R. Suhareli, and R. L. Richter, *Texas A&M University, College Station, TX.*

The purpose of this research was to evaluate the effect of the type of lecithin and homogenization pressure on the fractural properties of heat-set, whey protein emulsion gels. Mixtures for emulsions that contained 20% butteroil, 10% protein (WPC 80), and 0% lecithin or 1% deoiled soy lecithin (zwitterionic) or 1% deoiled acetylated lecithin (ionic) were prepared. Mixtures were heated to 65°C and homogenized at 20 and 90

MPa. The emulsions were heated at 90°C for 30 min to form gels. The gels were stored overnight at 4°C and fractural properties were measured in a Hamann torsion gelometer. Emulsions homogenized at 90 MPa exhibited yield stress which indicated that conformational changes of the protein occurred which exposed reactive groups of the proteins. Gels from emulsions homogenized at 90 MPa had higher shear stress at fracture and lower shear strain at fracture compared to gels from emulsions homogenized at 20 MPa. The increased surface area of protein-coated oil droplets and greater availability of reactive groups after homogenization at 90 MPa might have contributed to more intermolecular disulfide bonding during heat treatment. Gels that contained lecithin had lower shear stress and higher shear strain at failure at both homogenization pressures. SDS-Page showed protein displacement from droplets in emulsions with lecithin that were homogenized at 20 MPa but no protein displacement when homogenized at 90 MPa. The type of lecithin did not affect the fractural properties of gels, but zwitterionic lecithin displaced more protein from the lipid surface than did the ionic lecithin. However, this did not completely explain the effect of lecithin on gel strength. Interaction between lecithin with protein at the interface or with protein in the aqueous phase might have been responsible for the rheological changes of the gels.

Key Words: Whey protein gels, High homogenization pressure, Lecithin

T225 Microencapsulated Iron for drink yogurt fortification. H. S. Kwak, J. Ahn, and J. S. Seok, *Sejong University, Seoul, Korea*.

This study was designed to examine the effect of microencapsulated iron fortified drink yogurt and vit C as a bioavailable helper of iron on chemical and sensory aspects during 20 d storage. Coating material was PGMS, and ferric ammonium sulfate and vit C were selected as core materials. The highest efficiency of microencapsulation of iron and vit C were 73% and 76%, respectively, with 5:1:50 ratio (w/w/v) as coating to core material to distilled water. Iron fortification did not affect to the fermentation time required for the drink yogurt to reach pH 4.2. The addition of uncapsulated iron decreased the pH during storage. TBA absorbance was significantly lower in capsulated treatments than those in uncapsulated treatments during storage. In sensory aspect, the yogurt sample added with uncapsulated iron and vit C, regardless of capsulation, showed a significantly high score of astringency, compared with those of control and other groups. A significantly strong sourness was observed in treatment containing capsulated iron and uncapsulated vit C at every time intervals. The present study provides evidence that microencapsulation of iron with PGMS is effective for iron fortification in drink yogurt.

Key Words: Iron fortification, Microencapsulation, Yogurt

T226 Impact of flax oil emulsion composition on the oxidative stability of omega-3 enriched milk beverages. S. Lamothe*[1], G. Trudeau[2], and M. Britten[1], [1]*FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Qc, Canada,* [2]*Agropur, Granby, Qc, Canada*.

Milk enriched with flax oil could provide consumers with a means to meet the recommended daily intake of omega-3 fatty acids without changing eating habits. However, flax oil is extremely susceptible to oxidation. Pre-homogenization of flax oil in controlled conditions is proposed to slow down oxidation reactions. The objective of this study was to evaluate the oxidative stability of milk enriched with milk proteins-stabilized emulsions prepared from flax oil and butter oil. Emulsions (10% fat) were prepared in milk UF-permeate with pure flax oil, pure butter oil or a 25:75 (w/w) mixture of flax and butter oils. Homogenization was performed at 2000 psi with sodium caseinate (NaCas) or whey protein isolate (WPI) (1% protein) used as stabilizer. Fat concentration in skimmed milk was increased to 1% either with the mixed emulsion (method A) or a mixture of pure emulsions (method B) to reach 0.25% flax oil in the product. Milk samples were exposed to light and peroxide value (PV) and thiobarbituric acid reactive substances (TBARS) were monitored over a 40-hour period. The method used to enrich milk had a significant effect on light-induced oxidation ($p<0.01$). After the exposition period, PV and TBARS concentration in milks prepared according to method A averaged 45 mmole/kg and 4.8 μmole/L respectively. Oxidation of milk enriched according to method B, was more important with average PV and TBARS values of 91 mmole/kg and 8.0 μmole/L. The type of protein used to prepare flax oil emulsions had a strong influence on light-induced milk oxidation ($p<0.05$). Milk enriched with WPI-based emulsions showed PV and TBARS concentration significantly lower than milk enriched with emulsions made from NaCas. The results presented in this study demonstrated that the addition of butter oil to flax oil before homogenization resulted in an increased oxidative stability of enriched milks. High concentration of cysteine in WPI could also contribute to oxidation protection.

Key Words: Omega-3, Fluid milk, Oxidation

T227 Rheological Properties of Concentrated Skim Milk: influence of Heat Treatment and Genetic Variants on the Changes in Viscosity During Storage. A Bienvenue[1], H Singh[2], and R Jimenez-Flores*[1], [1]*Cal Poly Dairy Products Technology Center,* [2]*Massey University, New Zealand*.

Rheological properties of concentrated skim milks, with a total solids content of 45%, made from skim milk with defined genetic variants of β-lactoglobulin were studied as a function of shear rate and storage time at 50 °C. The effects of heat treatment of skim milk at 90 °C for 10 min prior to evaporation on apparent viscosity were also determined. All samples showed a decreasing apparent viscosity with increasing shear rate, with the presence of a yield stress. During storage of the concentrated milk, the apparent viscosity and yield values increased markedly, and that the age-dependent increase in viscosity in concentrated milks prepared from heat-treated skim milk was much more pronounced than those prepared from unheated skim milk. The increase in apparent viscosity and yield value with storage time was notably different for milks containing different genetic variants. Unheated concentrated milks containing the B variant of β-lactoglobulin showed most rapid increase in apparent viscosity with storage time while the viscosity increase was slowest in the concentrate containing the A variant. By contrast, heat-treated concentrated milks containing the A variant of β-lactoglobulin showed most rapid increase in viscosity with storage time while the viscosity increase was slowest in the concentrate containing the AB variant. The changes in apparent viscosity of concentrated milk were largely reversible under high shear during the early stages of storage, but samples stored for long time showed irreversible changes in apparent viscosity. Particle size analysis confirmed irreversible aggregation and fusion of casein particles during storage.

Key Words: Concentrated milk, Genetic variants, Rheology

T228 Effect of pore size and temperature on the fractionation of buttermilk using microfiltration. P. Morin*[1], R. Jimenez-Flores[2], and Y. Pouliot[1], [1]*Centre de recherche STELA, Universite Laval, Quebec, Canada,* [2]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.*.

Buttermilk is a unique dairy source of milk fat globule membrane (MFGM) lipids such as phospholipids and sphingolipids that have been recognized for their functional and nutraceutical properties. MFGM lipids can be isolated by solvent extraction but this approach is not suitable for dairy processing plants. Membrane processing such as crossflow microfiltration can be the first step to selectively concentrate buttermilk lipids which could be used to create novel functional ingredients. The use of microfiltration (MF) for the separation of MFGM lipids in buttermilk is restricted by the presence of caseins and whey proteins. A better knowledge of factors improving protein and lipid separation in buttermilk microfiltration is needed. Crossflow MF with 3 pore size (1.4 μm, 0.8 μm, 0.1 μm) and 3 temperatures (50°C, 25°C, 7°C) was carried out on fresh or reconstituted buttermilk. Transmission of lipids through the membrane was significantly ($p\leq0.05$) lower with the 0.1 μm membrane compared to the 0.8 and 1.4 μm membranes. However, retention level of proteins was the highest (78.3 %) using the 0.1 μm membrane and the lowest level was obtained using the 0.8 μm membrane (38.5 %). Temperatures tested did not induce significant ($p\geq0.05$) differences in protein transmission level and lower fat transmissions were observed at 25°C. Temperature increases had an important positive effect on permeation fluxes. Superior fat retention was also noticed using fresh buttermilk by opposition to reconstituted buttermilk. Phospholipids analysis

showed relative transmission of all main species of phospholipids found in buttermilk (phosphatidylethanolamine, phosphatidylcholine and sphingomyelin) at every combination of pore size, temperature and buttermilk type.

Key Words: Buttermilk, Microfiltration, Phospholipids

T229 Microbiological effects of pressurization with carbon dioxide on raw milk. M. Rajagopal*, J. H. Hotchkiss, and B. G. Werner, *Northeast Dairy Foods Research Center, Ithaca, NY/ USA*.

Addition of carbon dioxide at low pressures to raw milk was investigated as a non-thermal method to improve the keeping quality of raw milk. Our objective was to determine the effect of carbon dioxide on the indigenous microorganisms in raw milk. Raw milk was treated with carbon dioxide pressures between 68kPa and 689kPa and temperatures 20°C, 10°C and 6.1°C for 1 and 4 days. Survivor curves were expressed as $\log_{10}$(survivors) vs. time. Milk treated with 68kPa CO2 and held at 10°C demonstrated a lower growth rate compared to the untreated control. Higher pressures resulted in a reduction in numbers of survivors compared to initial counts. Treatment at 689kPa and 6.1°C resulted in an inactivation of approximately 1 log cycle after 4 days, while the untreated control increased by 2 log cycles. Enumerating for gram-negative bacteria and *Lactobacillus* sp. in the treated milk, treated to 6.1°C for 4 days did not show changes in proportions of these groups at all pressures. These data indicate that holding milk at low carbon dioxide pressures inactivates indigenous microorganisms in milk and may be a strategy for holding/shipping raw milk.

Key Words: Shelf life, Carbon dioxide, Milk

T230 Observation of bacterial exopolysaccharide in dairy products using cryo-scanning electron microscopy. A. Hassan*[1], J. Frank[1], and M. Elsoda[2], [1]*The University of Georgia, USA,* [2]*Alexandria University, Egypt*.

Cryo-scanning electron microscopy was used to visualize the microstructure of two types of cheese (karish and feta) and milk fermented with different ropy and nonropy strains of lactic acid bacteria. Specimen frozen in liquid nitrogen slush were transferred in a frozen state and under vacuum into the preparation chamber where they were fractured, etched and coated with gold. Specimen were then transferred under vacuum onto the cold stage and imaged using scanning electron microscopy. Milk fat and exopolysaccharide (EPS) were visible in pores within the protein network. Cheese and fermented milk made with EPS-producing cultures exhibited a porous structure in which the largest pores were associated with visible EPS. A compact structure with small pores was seen in cheese and milk fermented with EPS non-producing cultures. Exopolysaccharide and protein appeared to be segregated in both cheese and fermented milk. Exopolysaccharide formed a network-like structure. Differences were observed in the microstructure of EPS between moderately ropy and highly ropy strains. A relatively long etching (sublimation) time caused EPS to appear as thin filaments similar to those seen with conventional scanning electron microscopy.

Key Words: Cryo-scanning electron microscopy, Exopolysaccharide, Fermented dairy products

T231 Fat-level dependent impact of selected flavor volatiles on strawberry-flavored ice creams. S. T. Loeb*[1], I. U. Gruen[1], H. Heymann[2], K. Adhikari[1], L. N. Fernando[1], and R. D. Linhardt[1], [1]*University of Missouri, Columbia,* [2]*University of California, Davis*.

Consumer demand for healthier foods has led to an increase in development of reduced fat food products. Because many reduced fat products are not well accepted due to their overall flavor and texture profiles, it is necessary to study flavor-food interactions in order to produce more appealing low-fat and no-fat products.
The objective of this study was to determine the effect of full fat (10%) and low fat (4%) ice cream on the overall flavor and odor profile of selected artificial strawberry flavor components.
Ice creams with 4 and 10% fat levels were flavored with an artificial strawberry flavor composed of five components (*cis* 3-hexen-1-ol, ethyl-3-methyl-3-phenylglycidate, furaneol, γ-undecalactone, α-ionone). To determine the effect of fat on the individual flavor components, each of the five components were individually spiked at 200% of the base level to the flavored ice cream mixes before freezing. The spiked and control ice creams were then analyzed using generic descriptive analysis by a panel of 11 trained judges.
The attributes were grouped under appearance, flavor (aroma and taste), mouthfeel and aftertaste. All the 10% ice creams were perceived to have a flavor high in ethyl-3-methyl-3-phenylglycidate (candy-like), furaneol (cooked sugar), sweetness, creaminess, condensed milk and milk. The mouth feel was creamier, smoother and it imparted a greater mouth-coating impression. The 4% ice creams seemed to be impacted more by, iciness, *cis* 3-hexen-1-ol (leaf-like), γ-undecalactone (peach), and α-ionone (violet/woody).
The results indicate faster release of phenylglycidate and furaneol in 10% fat ice creams while in 4% fat ice creams the release was faster for hexenol, undecalactone and ionone. It can be concluded that fat level affects the perception of flavor compounds differently depending on factors such as hydrophobicity and interactions with lipids and proteins.

Key Words: Ice cream, Strawberry flavor, Descriptive analysis

T232 Microencapsulation of vitamin C and it's effect on iron bioavailability in iron fortified milk. H. S. Kwak, J. B. Lee, and Y. J. Lee, *Sejong University, Seoul, Korea*.

This study was carried out to investigate the fortification of vitamin C into milk by means of microencapsulation technique. The TBA value, sensory attributes, stability and bioavailability of iron microcapsules in milk during storage were measured. Coating materials used were polyglycerol monostearate (PGMS) and medium-chain triacylglycerol (MCT), and core materials were L-ascorbic acid and ferric ammonium sulfate. The yield of microencapsulated vitamin C was 95 % with MCT and was 94 % with PGMS when the ratio of coating material to core materials were 15 : 1, 5 : 1, respectively. The rate of vitamin C release was 4–9% when stored at 4° for 30 days, and temperature lower than 20° did not affect adversely vitamin C release in the milk during the storage. The TBA value was significantly lower in microencapsulated than those in uncapsulated vitamin C during storage. In sensory evaluation, the degree of sourness and off-taste were slight and total acceptability was moderate in 10mg vitamin C microencapsule -fortified milk at 8 day storage. In vitro study, microcapsules of vitamin C in simulated gastric fluid with the range of 2 to 5 pHs were released 4.7–13.2%, however, the capsules in simulated intestinal fluid with pH 8 were released 94.0% during 40 min incubation time. In the bioavailability of iron in vivo, transferrin saturation value of microencapsulated vitamin C and iron was two and half times higher than that of uncapsulated. In conclusion, this study provided that MCT and PGMS as coating materials were suitable for the microencapsulation of vitamin C and the microcapsules were effective on the bioavailability of fortified iron in milk.

Key Words: Vitamin C and Iron, Microencapsulation, Milk

T233 Effect of light exposure on flavor and oxidative stability of milk fortified with alpha-tocopherol and ascorbic acid. M. van Aardt*[1], S. E. Duncan[1], T. E. Long[2], S. F. O'Keefe[1], J. E. Marcy[1], and S. R. Nielsen-Sims[3], [1]*Food Science and Technology, Virginia Tech,* [2]*Chemistry, Virginia Tech,* [3]*Eastman Chemical Co*.

The effectiveness of added antioxidants against oxidation off-flavor development in light-exposed milk was evaluated using sensory and gas chromatographic analysis. Sensory similarity testing showed no perceivable difference between control milk and milk with added (i) α-tocopherol (0.05%) and (ii) α-tocopherol (0.025%) and ascorbic acid (0.025%), but did show a difference when adding ascorbic acid alone (0.05 %) (n = 30, $\beta = 0.05$, $\alpha = 0.30$). Subsequently, sensory difference testing showed a significant difference in oxidation off-flavor between light-exposed control milk and light-exposed milk with added α-tocopherol (0.025%) and ascorbic acid (0.025%), while addition of α-tocopherol (0.05%) alone showed no significant difference (n = 24, $\beta = 0.40$, $\alpha = 0.05$). Gas chromatographic analysis verified chemically the extent of oxidation for various antioxidant treatments. Since pentanal is a common light-oxidation by-product, its concentration was monitored over the 10 h period of light exposure. The controlled release of various natural and synthetic antioxidants from biodegradable polymer films

into model solutions (water, and Miglyol 812) was also evaluated as an alternative method of antioxidant addition.

Key Words: Natural antioxidants, Milk, Oxidation

T234 The storage stability of IGF-I fortified dairy products and its improvement by microencapsulation. S. H. Kang*[1], J. W. Kim[2], J. Y. Imm[3], S. J. Oh[4], and S. H. Kim[2], [1]*Seoul Dairy Cooperatives,* [2]*Korea University, Division of Food Science,* [3]*Kookmin University, Dept. Food & Nutrition,* [4]*Korea Yakult Co. Lt.*

The objectives of this study were to examine the stability of IGF-I fortified dairy products during storage and to suggest a process to improve storage stability. Powdered colostrum whey was used as a source of crude IGF-I and fortified to fresh milk, dried milk powder and yogurt at the level of 200 ng/ mL. The changes of IGF-I content in the fortified dairy products during storage were determined by radioimmunoassay using 125I at typical storage conditions. As a way to improve storage stability, IGF-I was encapsulated by surface reforming process (hybridization) using enteric coating materials (Sureteric and Eudragit L100-55) and the changes of IGF-I content were monitored. The IGF-I content in the fortified milk and dried powder was maintained during the tested periods (12 days for milk, 4 weeks for dried powder) but significant decrease ($p < 0.05$) was found during the storage of yoghurt for 3 wks. When the Powdered colostrum whey was coated with enteric wall materials before fortification, the IGF-I content in fortified yogurt was maintained during fermentation and no significant differences was found. Therefore, the enteric coating of IGF-I prior to fermentation can be used as an effective way to prevent degradation of IGF-I during fermentation.

Key Words: IGF-I, Storage, Enteric coating materials

T235 Use of chemical mutagenesis approach and spiral-sheet bioreactor for the production of lactose free milk. S. A. Ibrahim*[1], M. M. Salameh[1], G. Shahbazi[1], R. R. Shaker[2], and V. Shirley[1], [1]*North Carolina A&T State University,* [2]*Jordan University of Science and Technology.*

Lactose intolerance is the inability to digest milk sugar, lactose, causing gastrointestinal symptoms of flatulence, bloating, cramps and diarrhea in some individuals. About 75% of the world's population and approximately 90% of black Americans have some difficulty digesting lactose. Commercial lactase products are not usually the best choice for lactose intolerance, because even when these treatments provide relief they often produce other digestive tract distress symptoms. The purpose of this research was to develop a procedure that can reduce lactose content in milk. In this research, chemical mutagenesis was used to produce a cold resistant, over producing mutant of lactic acid bacteria that hydrolyze lactose to glucose at refrigerated temperature. *Lactobacillus helveticus* was tested by a single exposure to two chemical mutagens, ethyl methanesulfonate (EMS) and N-methyl-N'-nitro-N-nitrosoguanidine (MNNG). To screen for β-galactosidase (β-gal) overproducing mutants, optimized EMS and MNNG mutant pots for *L. helveticus* were plated on BHI agar containing 5-bromo-4-chloro-3-indolyl-β-D-galactopyranoside (X-gal). Colonies that exhibited a blue color were selected for quantitative β-gal activities using the o-nitrophenyl-β-galactoside (ONPG) assay. Three mutants were obtained that exceeded the wild strain β-galactosidase activity levels (70 vs. between 80 and 320 Miller units, respectively). Mutants were then immobilized on a spiral-sheet bioreactor for continuous conversion of lactose into glucose at 4 C. Approximately 65% of lactose was converted into glucose. This technology has the potential for helping dairy farmers increase the market for dairy foods, address public health concerns and enhance the nutritional quality and safety of dairy foods.

Key Words: *Lactobacillus helveticus*, Lactose free milk

T236 Milk protein composition and its role in the phase separation phenomenon in soft-serve ice cream. C. Vega* and D. Goff, *University of Guelph, Guelph, ON, Canada.*

Incompatibility between milk proteins (especially casein) and polysaccharide stabilizers, such as Locust Bean Gum (LBG), renders a characteristic phase separation phenomenon in soft serve ice cream mixes subject to long storage periods. The inclusion of k-carrageenan in levels above 0.015% is effective in avoiding such event, but the mechanism is not well understood. An study of the composition of the milk protein revealed that casein micelles seem to be necessary to allow k-carrageenan to be functional. The use of sodium caseinate (NaCas) instead of skim milk powder (SMP) at a constant protein content and casein:whey protein ratio, at equal polysaccharide (LBG, k-carrageenan) concentrations, showed that the SMP system is more stable against separation. This suggests that k-carrageenan interacts with k-casein and, since the latter is still attached to the casein micelle in SMP and not in NaCas, it is possible for the stabilizer to better "hold" the SMP mix from wheying-off. Analysis of different whey to casein ratios (at constant protein concentration) have shown that as casein proportion diminishes (from 70 to 10%), the polydispersity and instability of the mix decreases. This suggests that casein induces polydispersity, which in turn manifests as instability during storage. This finding is consistent with the fact that as emulsifier (polmo) content is decreased (from 0.3 to 0%), the proportion of casein adsorbed by the fat globule increases, leaving less amount of protein exposed in solution to interact with LBG, hence less separation. This event occurs at constant k-carrageenan concentration leading to the conclusion that, as the proportion of this stabilizer versus casein increases, it becomes more efficient.

Key Words: Carrageenan, Ice cream, Casein

T237 Optimization of Solid Phase Microextraction(SPME) for the analysis of volatile compounds in milk. H. Clarkson*, S. Duncan, and S. O'Keefe, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

Solid Phase Microextraction (SPME) is a relatively new technique for analysis of volatile compounds. The sensitivity of milk compounds to light wavelengths and impact on odor and flavor needs further study. Several carbonyl compounds, including ketones, aldehydes, acids and dimethyl sulfide, contribute to the odors and off-flavors produced in milk due to light exposure. Application of SPME to this purpose requires additional knowledge of methodology variability. Water and milk were spiked with 1-hexen-3-one, dimethyl sulfide, pentanal and butyric acid as representative compounds. Volatiles were trapped by SPME, condensed by cryofocusing, and quantified by gas chromatography. Equilibration time (12, 17, 22, 32, and 37 minutes) and SPME fibers (PDMS, PDMS/DVB, Car/PDMS) were compared for optimum detection of compounds in headspace of water and milk. Equilibration was optimized at 22 minutes for water using the CAR/PDMS fiber. Intra-variability was 7% for pentanal in water, as a representaative compound. Inter-variability was as high as 15% for compounds in water. Variation in detection of representative compounds was found for milk among the SPME fibers.

Key Words: SPME, Milk, Volatiles